



STUDY OF RELATIONSHIPS BETWEEN ACTIVITY,
REACTION, GARMENT PARAMETER PATTERNS
AND INJURY SEVERITY FOR FIRE INCIDENTS
INVOLVING APPAREL

Laura Baker Buchbinder

Fire Technology Division
Institute for Applied Technology
National Bureau of Standards
Washington, D. C. 20234

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AN INTERIM REPORT

1. INTRODUCTION AND PURPOSE OF STUDY

1.1. Introduction

It is generally accepted that burn accidents result from the interaction of a number of environmental, human, and physical factors. The circumstances leading to the accident, the nature of the accident itself, the involvement of flammable fabrics and/or flammable liquids, the availability of help, and the reaction of the victim to the fire are all variables which may differentiate between a minor accident and a major burn injury [2,4]¹.

The extent and severity of a burn injury largely determine the consequent human and economic cost [1,3,4,5]. Partial thickness (1st and 2nd degree) burns involving 10% or less of the total body area are relatively easy to treat, usually do not require extensive hospitalization and generally result in no permanent disfigurement, while 2nd and 3rd degree burns involving 50% or more of the total body area require prolonged, expensive hospital care and often result in death to the victim. Burns of a level between the extremes may result in a variety of consequences depending upon the location and severity of the burn, the age and physical condition of the victim, and the treatment received.

Previous investigations of fire accident loss using data from the National Bureau of Standards, Fire Technology Division, Flammable Fabrics Accident Case and Testing System (FFACTS), have primarily dealt with one or two parameters at a time in describing the numbers of accidents and deaths in fires involving flammable fabrics. Little has been done thus far to relate level of severity of burn injury to the interaction of environmental, human, and physical factors surrounding apparel fire accidents.

¹Figures in brackets indicate the literature references at the end of this paper.

1.2. Purpose of Study

The purpose of this study is to identify patterns in those variables which describe the activity preceding the accident, the reactions of the victim to ignition, the parameters of the fabrics and garments involved, and the level of severity of the injury, and to define the extent and nature of the relationships between these accident variables. The study will be based on an analysis of FFACTS data.

The relationships defined in the study will aid in defining the types of remedial action (such as educational programs, redesign of ignition sources, and voluntary or mandatory standards) which are likely to be most effective in reducing human and economic loss due to apparel fires.

The multidimensional nature of the study should also allow a more complete understanding of the total burn problem and aid in placing the various factors leading to a burn injury into proper perspective.

2. INTERIM REPORT CONTENTS

The body of this interim report contains a detailed description of the overall study in section 3, and an outline of the current status and remaining effort in section 4.

The qualitative nature of the main study variables involving activity, reaction and garment details necessitated the creation of several variable classification systems. Value judgements were made in both the development and application of these systems. The appendix of this report contains preliminary observations, based on reading 500-600 case histories, on the classification system for one of the study variables, namely, activity. These detailed observations are presented to reflect the flavor of the initial activity classifications, to demonstrate the level of detail available from the case histories, and to show the recurrence of activity patterns in fire accidents. The final classification of activities will be made when all cases have been read, and section 3.3.4. describes how the classifications for activity and the other main study variables will be coded and added to the FFACTS data file. The classification and coding systems will not be hierarchal. They will identify recurring behavior and garment parameter patterns at the lowest classification level. The combination of these codes, the data already in FFACTS, and the injury severity index to be developed, will be used to analyze the relationships between the main study variables.

3. STUDY DESCRIPTION

This section outlines the entire study. Section 3.1. describes the pilot study which defined the scope of the main study. The method of collecting data from the FFACTS case histories is detailed in section 3.2. The systems for classification of the collected data in terms of activity pattern, reaction pattern and garment parameters pattern are presented in detail in section 3.3. Section 3.3.4. describes the addition of these classifications to the computerized data base. Section 3.4. defines the use of data already in the FFACTS data file. The development of an injury severity index is described in section 3.5. Finally, section 3.6. discusses the data analysis plans.

3.1. Pilot Study

Prior to beginning the comprehensive research project, over fifty case histories were studied in detail. It was determined that the case histories often give detailed information regarding the victim's activity prior to the accident, the victim's reaction to ignition of clothing, and the configuration of the garment involved, that cannot be retrieved from the computerized data file. It was also noted that similar patterns appear again and again in burn accidents, suggesting that categorization of activities, reactions and garment parameters might be possible. Information gained in the pilot study was used to determine the focus and scope of the more comprehensive study, and aided in the development of a data collection form designed specifically for this study.

3.2. Data Collection from Case Histories

3.2.1. Criteria for case selection

The NBS FFACTS data base, numbering 1,964 cases at the cutoff date of November 1, 1972, was used for this study. The cases selected from that data base for detailed analysis were those involving apparel for which information was available on the total area of body burned, and on either the activity preceding the burn or the reaction to ignition, or both.

3.2.2. Development of Data collection form

The FFACTS computerized file is comprehensive, with up to 200 data elements coded for each fire accident. The data are derived from detailed incident investigation reports supplied mostly by the Food and Drug Administration using questionnaires developed in cooperation with the National Bureau of Standards, Fire Technology Division. In addition to

the data on the questionnaires, each incident investigation report contains a narrative description of accident details based on personal interviews.

A one page data collection form (figure 1) was developed for recording detailed information given in case narrative descriptions, to supplement the data available from the coded FFACTS file.

3.2.3. Use of data collection form

Cases meeting criteria for inclusion in the study were read, and pertinent information was entered on the data collection forms. The case number was included for reference and flammable liquids involvement was noted, as was the occurrence of an explosion.

The activity of the victim before and during ignition was recorded, along with any other pertinent information given in the case history which might explain the activity or the reaction of the victim.

A summary of the reactions of the victim and other people directly involved in the accident, to garment ignition was recorded for more detailed analysis.

The garment(s) judged to have contributed most to the severity of the injury were identified and were roughly classified as to degree of fit. Whenever possible the point of ignition was noted and a comparison made between area of victim burned and area of garment burned.

3.3. Classification of Data From Case Histories

After data collection forms were completed for over 500 cases, initial classification was made into activity, reaction and garment configuration categories, as described below.

3.3.1. Activity pattern classification

An activity pattern classification system (figure 2) was developed by grouping similar accident activity types. The criteria used in determining activity classifications were the ignition source, the location of the accident, and the activity of the victim at the time of the accident. Specific activity patterns were grouped and listed under five broad categories:

- Non-work-related or leisure activities indoors
- Non-work-related or leisure activities outdoors

DATA COLLECTION FORM

Case No. _____ A.C. _____ R.C. _____ G.C. _____
ACTIVITY _____ FLAMMABLE LIQUID _____ EXPLOSION _____ OTHER _____

Before Ignition:

During Ignition:

Comments:

REACTION

Summary:

GARMENT CONFIGURATION

Primary Item Type 1. _____ Primary Item Type Unknown _____
2. _____

Garment Geometry

1. Fit: Loose _____ T.&L. _____ Tight _____ Unknown _____ Other _____
Sleeves: Long, full _____ Long, tight _____ Sleeveless, Short _____ Not Applicable _____ Other _____
Garment Involvement: _____

2. Fit: Loose _____ T.&L. _____ Tight _____ Other _____
Sleeves: Long, full _____ Long, tight _____ Sleeveless-Short _____ Unknown _____ Other _____
Garment Involvement: _____

Figure 1. Data collection form.

Figure 2. Activity Pattern Classification

- I. Non-work-related or Leisure Activities--Indoors
 - A. Smoking and related activities
 - 1. No flammable liquids involved
 - a. Smoking in bed
 - (1) Lighting a match or cigarette lighter
 - (2) Smoking a cigarette, cigar, or pipe
 - b. Smoking while under the influence of drugs
 - (1) Lighting a match or cigarette lighter
 - (2) Smoking a cigarette, cigar, or pipe
 - c. Smoking by the senile, mentally or physically handicapped
 - (1) Lighting a match or cigarette lighter
 - (2) Smoking a cigarette, cigar, or pipe
 - d. Other
 - (1) Lighting a match or cigarette lighter
 - (2) Smoking a cigarette, cigar, or pipe
 - 2. Flammable liquids involved
 - B. Activities near a space heater or open fireplace
 - 1. No flammable liquids involved
 - a. Warming by heater or fireplace
 - b. Standing or walking by heater
 - c. Playing with or near heater
 - 2. Flammable liquids involved
 - C. Playing indoors with smoking materials
 - 1. No flammable liquids involved
 - 2. Flammable liquids involved
 - D. Other indoor non-work activities
- II. Non-work-related or Leisure Activities--Outdoors
 - A. Camping out or activities involving an open fire
 - 1. No flammable liquids involved

2. Flammable liquids involved
- B. Lighting or tending a charcoal grill-flammable liquid involved
- C. Playing with matches, flammable liquids, fireworks, or explosives--outdoors
 1. Playing with matches
 2. Playing with flammable liquids
 3. Playing with fireworks or explosives
- D. Other outdoor non-work activities

III. Work-related Activities--Indoors

- A. Activities involving ranges
 1. Ignition from open flame or heating elements - activity classification
 - a. Actively engaged in food preparation
 - b. Watching food preparation
 - c. Warming during food preparation
 - d. Playing or climbing on or near range
 2. Ignition from open flame or heating element - action classification
 - a. Leaning or reaching over range - front ignition
 - Reaching for something over range
 - Turning away from or walking close to range
 - Leaning over close to burner
 - Reaching over front burner to controls at back
 - Reaching over front burner to rear burner
 - b. Leaning or reaching over range - sleeve ignition
 - Reaching to pan at rear of range
 - Moving near range

- c. Leaning, working or standing near range -
back ignition
 - Leaning back against range
 - Warming self by range
 - Standing with back to range
 - Working near or turning away from range
- d. Climbing on range

B. Maintaining the home

- 1. No flammable liquids involved
- 2. Flammable liquids involved
 - a. Painting or cleaning paint brushes
 - b. Using volatile glue
 - c. Tending furnace
 - d. Other
- 3. Explosive ignition
 - a. Painting or cleaning brushes
 - b. Lighting furnace or water heater
 - c. Other

C. Repairing or cleaning automotive or mechanical parts

D. Other

IV. Work-related Activities--Outdoors

A. Working in yard or grounds

- 1. Burning trash, brush, or grass
 - a. No flammable liquid involved
 - (1) Standing near or actively tending fire-spark ignition
 - (2) Tending trash fire-explosive flashback ignition
 - b. Flammable liquid involved
 - (1) Flammable liquid added to fire
 - (2) Flammable liquid on clothing ignites

2. Playing with or near existing trash fire
 - a. No flammable liquids involved
 - b. Flammable liquids involved
 3. Other accidents involving yard maintainance
- B. Maintaining or repairing engines, automobiles, etc.
1. Priming carburetor - flammable liquids involved
 2. Other mechanical work
- V. Job-or Occupation-related Activities
- A. Agricultural or outdoor occupations
 - B. Automotive-related occupations (maintainance or repair)
 - C. Manufacturing or industrial occupations
 - D. Other occupations

- Work-related activities indoors
- Work-related activities outdoors
- Job-or occupation-related activities

Additional activity patterns may be identified when data collection is completed.

3.3.2. Reaction pattern classification

Since a victim's success in extinguishing a fire is dependent upon his defensive capability and the type of defensive action he takes, both of these elements were included in the reaction classification (figure 3).

3.3.2.1. Defensive capability

This classification addresses the capability of the victim to assess the situation and extinguish the fire quickly and efficiently.

3.3.2.2. Defensive action

Common reactions of people involved in burn accidents were identified. To facilitate analysis of the data each reaction was classified as positive, negative, or neither.

3.3.3. Garment classification

Case histories offer two types of garment information not readily available from the computer. These are garment configuration or geometry and garment contribution to injury, as detailed below.

3.3.3.1. Garment configuration

Garments involved in fire injuries were classified by overall shape and degree of fit.

The overall shape categories were "fitted waistline" and "nonfitted waistline". Sleeve shapes were classified as well (figure 4).

Degree of fit classification was accomplished with the aid of sketches (figures 5a, 5b, and 5c) of the garment types defined in the shape classification. Estimates were made on the closeness of fit at various areas on the body with "tight fit" defined as less than 2 inches of ease, "medium fit" defined as 2 inches - 5 inches of ease and "loose fit" defined as more than 5 inches of ease. In actual garments, areas of tight, medium, and loose fit are not well defined

Figure 3. Reaction Classification

- I. Defensive Capability
 - A. Positive factors
 - 1. Immediate recognition of danger
 - 2. Normal adult reaction capability
 - 3. Help available
 - B. Negative factors
 - 1. Delayed recognition of danger
 - 2. Slow or illogical reaction due to age, physical or mental condition
 - 3. No help available
- II. Defensive Action
 - A. Positive reactions
 - 1. Beat flames with hands
 - 2. Rolled on ground
 - 3. Wrapped in rug, blanket, pillow, etc.
 - 4. Doused with water
 - 5. Tried to remove garment(s)
 - 6. Other
 - B. Negative reactions
 - 1. Took no immediate action-stunned
 - 2. Ran
 - 3. Struggled with help
 - 4. Other
 - C. Neither positive or negative
 - 1. Ran to escape flames
 - 2. Reaction unknown

Figure 4. Garment Configuration Classification

I. Body of Garment

A. Non-fitted waistline

1. Loose top

- a. Blouse or shirt (not tucked in)
- b. Pajama top

2. Semi-loose top

- a. Sweater
- b. T-shirt

3. Shift

- a. A-line dress
- b. Duster
- c. Gown

4. Long shift

- a. Robe
- b. Nightgown
- c. Formal wear

B. Fitted waistline

1. Dress configurations

- a. Dress-fitted waistline
- b. Shirt and blouse combinations

2. Pants configurations

- a. Shirt and pant combination-fitted (shirt tucked in)
- b. Top and pant combination-loose
 - (1) Pajama bottoms
 - (2) Coveralls, etc..

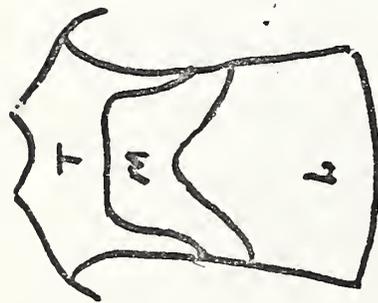
II. Sleeves

A. Long

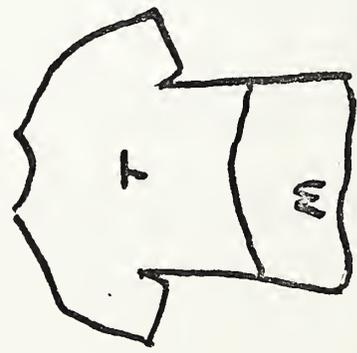
1. Straight
2. Bell
3. Bishop

B. Short

1. Straight
2. Puffed
3. Fitted knit



Loose Top



Semi-loose Top



Shift



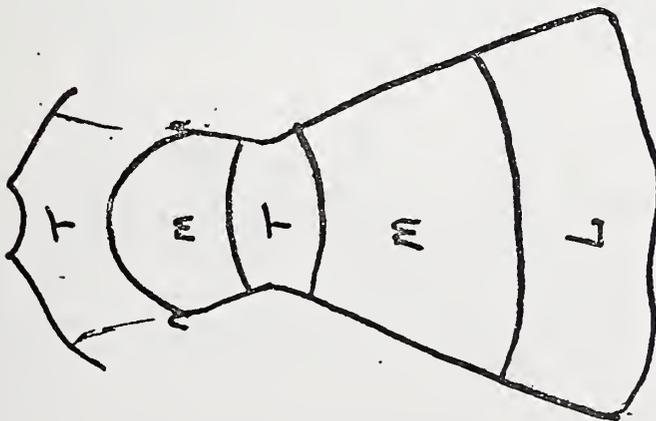
Long Shift

T = Tightly fitted (less than 2 inches ease)

M = Medium fitted (2-5 inches ease)

L = Loosely fitted (Over 5 inches ease)

Figure 5a. Non-fitted waistline configurations - Degree of fit.

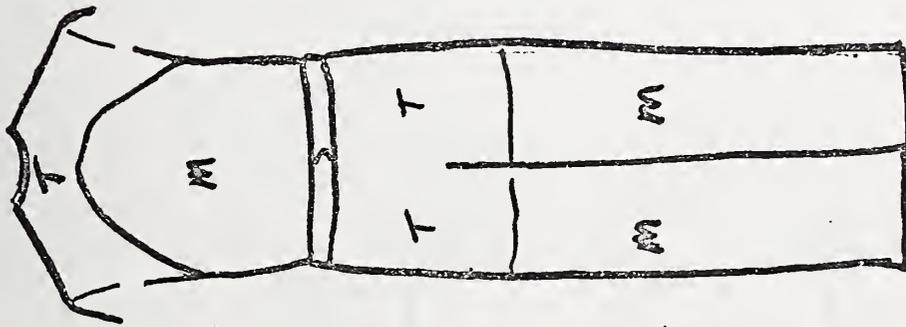


Dress-Fitted waistline

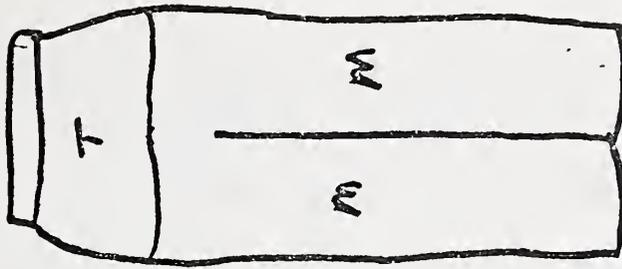
T = Tightly fitted

M = Medium fit

L = Loosely fitted



Shirt and Pant Combination
(Fitted Pants)



Pants - Loose

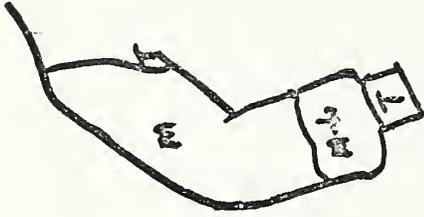
Figure 5b. Fitted waistline configurations - Degree of fit.



Straight-Long



Bell



Bishop



Straight-Short



Puffed



Fitted knit

T = Tightly fitted

M = Medium fit

L = Loosely Fitted

Figure 5c. Common sleeve configurations - Degree of fit.

and vary from garment to garment. It should be noted, therefore, that these sketches offer only a rough approximation of fit.

Using these representations, garments will be classified as to their degree of fit both in the area of ignition and in the area of most severe burn injury.

3.3.3.2. Garment contribution to injury

From information given in the case history and from a comparison of the part of the garment burned^{1/} and the area of injury, a classification system to define the garment contribution to the severity of injury was developed. The following criteria were developed to classify the level of garment involvement:

- Primary agent
If the garment was first to ignite with no flammable liquid on the garment and covered the portion of the body with the most severe burns, the garment may be considered a primary agent.
- Secondary agent
If there is an indication of a flammable liquid on the garment at the time of ignition, or if the garment was not first to ignite or was not worn in the area of most severe or extensive injury, the garment may be considered a secondary agent.
- Not involved
If the garment did not ignite and/or affect the level of injury, the garment may be classified as not involved.
- Protective
If the injury was more severe in areas not covered by the garment and the garment self-extinguished or did not ignite, the garment may be classified as protective.

^{1/}

This could be most accurately accomplished by comparing the area burned on the actual garment to the burn diagrams included in the case history. However, due to the time limitations of this study, an approximation of the extent of involvement and area of the garment burned will be made using information given in the case narrative.

° Unknown

Information given is insufficient to determine garment involvement.

In fires where multiple garments were involved, only the one or in some cases two, garments which were major contributors to the injury will be considered in this study. Cases in which the victim would have been badly burned regardless of what he was wearing will not be included.

3.3.4. Classification coding

Upon completion of the classification of cases, codes for activity, reaction, and garment configuration classifications (A.C., R.C., and G.C.) will be developed and entered at the top of each data collection form (figure 1). These codes will be added to the computerized FFACTS file.

3.4. FFACTS Data File Input to Analysis

The coded data described in section 3.3.4. represent the quantification of activity, reaction, and garment configuration. These data on the main study variable will be supplemented by data already in the FFACTS data file, for the analysis phase of the study. The supplementary data will include such variables as age, sex, economic and educational level (of victim or family), as well as garment weight and fiber content.

3.5. Injury Severity Index Development

One or more candidate injury severity indices will be developed, based on such factors as total area of body burned, area of full thickness burn, age of victim and number of days in hospital. These indices will be added to the computerized file and used in the initial analyses. A single such index may emerge to represent injury severity in subsequent analyses.

3.6. Analysis of Data

The major variables of interest are those which describe activity, reaction, garments, and injury severity. Additional variables, such as ignition source, ignition sequence, age and sex of victim and possibly socio-economic level will be included in the study so that their influence on the major variables may be accounted for. Appropriate statistical techniques will be applied in analyzing the data; the exact sequence of analyses to be performed will be determined by the initial results. At a minimum, descriptive methods will be applied to characterize in detail the relationships between the major variables for the accident patterns

identified. Such systematic tabular and graphical presentations will provide guidance to remedial action programs.

In addition, partial correlation analyses may be performed, and multiple regression analyses will be run if it appears feasible to represent injury severity as a linear function of some or all of the other study variables. If the data do lend themselves to these more sophisticated analyses, care will be taken to limit the inferences drawn to appropriately reflect the manner in which the FFACTS cases were accumulated and the degree to which extrapolations may properly be made to the national fire accident picture.

4. CURRENT STATUS AND REMAINING EFFORT

This study is predicated upon the quantification of qualitative data regarding activity, reaction, and garment configuration. The relationships under investigation are complex and a large number of case histories is required for the study because of the large number of combinations of accident parameters, reflecting different accident types; therefore, data handling must be automated. Before any detailed analysis is performed, it is necessary to quantify the main study variables via the classification and coding process. Until this quantification process is completed, preliminary results are limited to observations on accident patterns, such as those presented in the appendix relative to activity classification. This section outlines the current status and remaining effort.

4.1. Current Status

The following portions of the study have been completed:

- Pilot study to define main study scope and develop data collection form.
- Preliminary review of literature.
- Completion of 60% of data collection from reading case histories.
- Development of activity, reaction, and garment configuration classification systems.
- Preliminary observations on activity type classification.
- Completion of an interim report.

4.2. Remaining Effort

The remaining effort may be described by the seven areas listed below:

- Completion of data collection - Approximately 500 cases remain to be read for data collection on the report forms.
- Final classification of activities, reactions, garment configurations and garment contribution to injury - The data on the data collection forms will be classified and coded.
- Completion of literature review - Main area of concern will be background for injury severity index development.
- Development of severity indices - One or more indices of injury severity will be developed and coded for each case.
- Development of computer programs for data analysis - Programs will be written for data retrieval (coded classification, injury severity indices and previously coded FFACTS data), and for analysis.
- Analysis of data - The extent of the analysis will be governed by the results as they unfold and by the time available (See section 3.6.).
- Publications - The number and type of publications will also be governed by the results achieved and time available. It is anticipated that publications will be of two types. First, technical exposition of analytical results in the form of an NBS Technical Note and possibly papers for presentation to and publication by technical societies. Second, popularized articles for the general public, for consumer education.

APPENDIX

PRELIMINARY OBSERVATIONS ON ACTIVITY TYPE CLASSIFICATIONS

Based on the 500-600 FFACTS cases already read, grouped and classified by activity type, certain patterns were noted within the various categories. These patterns are tentatively identified below. The classifications may be modified with the addition of the remaining data.

1. Non-work-related Leisure Activities - Indoors

1.1. Smoking and related activities

Accidents involving the use of smoking materials by adults most often occurred while the victim was in a seated or prone position. However, the activities other than smoking in which they were involved varied from case to case.

Certain patterns were noted in the 59 cases studied to date. The majority (42 out of 59) of the accidents occurred under one or more of the following circumstances:

- The victim was unusually tired or sleepy
- The victim was in bed or ready for bed
- The victim was drunk or sedated
- The victim was senile, physically handicapped or mentally inadequate
- The garment involved had a napped or pile surface.

Flammable liquids did not seem to play a major part in accidents involving smoking; however, a category of such cases included lighting a match when clothing had flammable liquid on it, and lighting a cigarette near a volatile liquid thus causing an explosion or flashback.

1.2. Activities near a space heater or open fireplace

Space heaters seemed to present more of a hazard to children than to adults. Two patterns involving open fires in the home seemed to emerge.

- A child, wearing a loosely fitted garment backed up to the heater to get warm. As the victim attempted to get close to the heat, the edge of his garment came in contact with an open flame and ignited.

- The victim's loosely fitted garment came in contact with the flame or heating element while engaged in some other activity such as dressing, working at the sink, or playing near the heater. In most instances the room or work space containing the heater was small or cramped and the victim was busy or pre-occupied.

Accidents from both of the above categories have two common elements.

- Lack of an adequate guard on fireplace or heater
- Victim wearing a loosely fitted, often long garment

Flammable liquids were not a problem with indoor fires such as the above.

1.3. Playing indoors with smoking materials (children)

The exact accident sequence is unknown since no adult was present. However the pattern appeared to be as follows:

(1) The child obtained matches or lighter. In most cases these materials were easily accessible, but in a few instances the child went to some effort to obtain them.

(2) The child either began to play with them immediately or he took them elsewhere to play with them, where discovery was less likely.

(3) The child dropped the match or lighter after lighting it, thereby igniting his clothing.

Other observations on this accident type were:

- More children were injured playing with matches than with lighters.
- More children were injured while playing alone than while playing with other children.
- In a number of cases, the children had played with fire before, some having been burned in the process.
- Though occurring at all income levels, this type of accident seemed to be more prevalent in large families at low income levels.
- The accident often occurred in the morning, either before the parents were awake or while the parents were busy elsewhere.

Flammable liquids were seldom a factor in accidents involving children playing with smoking materials indoors.

1.4. Other indoor non-work activities

- No real patterns yet identified.

2. Non-work-related or Leisure Activities - Outdoors

2.1. Camping or activities involving an open fire

Accidents involving an open fire most often occurred while the victim was warming himself by a campfire. The victim stood too close and the clothing ignited either from a spark or by the wind blowing the flames.

Flammable liquids were involved in about half of these accidents. Typical situations were:

- Flammable liquid on clothing ignited when the victim stood too close to the flame
- Flammable liquid was thrown on an existing fire causing a flashback
- Children or adolescents were playing with a flammable liquid near a fire and vapors or liquid ignited.

2.2. Lighting or tending a charcoal grill

All accidents studied thus far involving a charcoal grill were strikingly similar. The victim put charcoal in the grill and added lighter fluid or the equivalent to the coals. The coals were then lighted. Sometime later the victim decided the fire wasn't progressing fast enough and added more fuel, often gasoline which is more volatile than most lighter fuel. The flammable liquid and/or vapors ignited with one or more of the following consequences:

- Victim spilled flaming liquid on himself as he jumped or prepared to fling the container away.
- The can or container holding the flammable liquid exploded, spewing its contents on the victim.
- Exposed portions of the victim's body were burned by the flashback or explosion.

2.3. Playing with matches, fireworks, explosives or flammable liquids - outdoors (children)

The accident sequences of children playing with matches outdoors were similar to those of children playing with matches indoors, except that more intermediary materials (leaves, sponges, paper, etc.) appeared to be involved outdoors than indoors. There were a few cases in which the child had flammable liquids (such as grease, oil or gasoline) on his clothing when he played with matches, thus increasing the flammability of the fabric.

There were a number of cases in which the child was actually playing with a flammable liquid at the time of the accident. The most common type of accident involved the child pouring the flammable liquid on the ground or in a cup and igniting it. The burn occurred as a result of the explosion or backflash which ignited the clothing, or clothing ignition as the child tried to extinguish the fire.

Another accident sequence involved a child pouring gasoline on leaves or on other objects, lighting them, and igniting his clothing in the process.

The accessibility of flammable liquids to children was the outstanding factor in these accidents. In most cases, the child either found the flammable liquid by accident or got it from the garage where it was commonly stored.

Fireworks also presented a hazard, with sparklers being the major offenders. Clothing ignition occurred either while the sparkler was being lighted or when a spark or piece of the sparkler broke off and lodged in his clothing.

Explosives were involved in only two of the incidents studied thus far.

3. Work-related Activities - Indoors

3.1. Activities involving ranges

Activities of victims involved in range accidents may be classified into four broad categories:

- Those in which the victim was actually preparing food
- Those in which the victim was waiting to eat or was talking with or watching another person prepare food
- Those in which the victim was warming himself by the range

- Those in which the victim, a child, was climbing on or playing near the range.

A number of body actions or movements, such as leaning over, standing near, leaning against, or reaching over, may be associated with range-related activities. A common action which led to ignition was leaning back against the range while the front burner was turned on or still very hot. The victim was generally:

- Preoccupied with something else such as talking on the phone, watching TV, or reading the paper
- Waiting for something to heat
- Wearing something loosely fitted at the waist or upper hip
- Standing near a partially covered burner or one with the flame turned up too high

Range-related accidents involving explosions or flash-back most often occurred when the victim attempted to light an oven in which there was an accumulation of gas. The trapped gas ignited explosively burning exposed areas of skin and at times igniting the victim's clothing. The gas accumulation was generally due to a faulty pilot light, failure to turn off burners completely, or a time lag between turning on gas and striking a match. [A similar but less serious accident occurred on top burners when gas had accumulated before ignition].

There were also several cases in which grease left unattended on the range ignited. Generally the injury occurred when the victim attempted to carry the burning grease from the kitchen, dropping or spilling it on himself in the process.

3.2. Maintaining the home

The few accidents related to home maintenance or repair in which there were no flammable liquids involved were electrical in nature, most involving an electrical short circuit.

Most accidents connected with home maintenance involving flammable or volatile liquids fell into one of three categories:

3.2.1. Cleaning paint brushes

The victim was using gasoline or paint thinner to clean paint brushes. Fumes accumulated in the room and were ignited by a hot water heater or other ignition source. An explosion

or flashback occurred which caused burns to exposed area and/or ignited flammable liquid on clothing.

3.2.2. Tending the furnace

The majority of these accidents occurred when the victim was trying to re-light or check on a furnace that had gone out. Generally, accumulated gas ignited causing an explosion or flashback which burned exposed skin and/or ignited the victim's clothing.

3.2.3. Using volatile or flammable glue with inadequate ventilation

After spreading the glue or contact cement over most of the surface to be covered, the fumes were ignited by a hot water heater, range, or other ignition source, causing a small explosion and fire.

3.3. Repairing or cleaning automotive or mechanical equipment

This accident type was characterized by the use of flammable liquids, usually gasoline to clean automobile or motorcycle parts, or other small pieces of equipment, in a poorly ventilated room. While the ignition source varied from a cigarette to a water heater, the sequence was much the same in all cases. Flammable liquid was brought inside the house to be used, and ignition occurred in one of the following two ways:

- Gas was spilled and ignited from a pilot light or heater
- Vapors from gas accumulated and were ignited causing a flashback or explosion.

4. Work-related Activities - Outdoors

4.1: Working in yard or on grounds

A relatively large number of accidents occurred while the victim was working in the yard or on the grounds surrounding the home. Most of these accidents involved open trash or brush fires.

In those accidents which did not directly involve flammable liquids, there were two prevalent sets of circumstances.

In the first instance, a trash or brush fire was disturbed or fanned either by the victim stirring or kicking it or the wind blowing it. Sparks or burning trash from the fire then landed on the victim's clothing (usually pants leg) causing ignition. Brush fires differed from trash fires only in that they were usually larger and more likely to get out of hand. In two of the four brush fire cases classified to date, ignition occurred as the victim was trying to extinguish a fire that had gotten out of control. In the other two cases, ignition was believed to have been caused by sparks given off as the victim added fuel to the fire.

The second category of yard fires involved an explosion or flashback which led to a burn and/or clothing ignition. In several instances a minor explosion was caused by something, such as an aerosol can, which exploded when placed with trash in an incinerator. In other instances the trash was believed to have been contaminated with a flammable liquid causing a flash of flame when the trash was ignited.

Flammable liquids also played an important part in yard and grounds maintenance activities. The most common accident sequence involved the use of flammable liquids in trash or brush fires. In many respects the accident pattern was similar to that of the charcoal grill accident. After the fire had been started the victim decided that it wasn't burning fast enough and added flammable liquid (usually gasoline) to it. The liquid or its vapors ignited causing a minor explosion or flashback. The victim was burned by the flashback and/or by flaming liquid spilled or splattered on him.

Another accident pattern relating to yard fires was also identified. In the process of carrying or using the flammable liquid for starting a fire, some of it spilled on the victim's clothing. The contaminated area ignited as the victim was tending the fire.

Other types of yard accidents involving adults were reported, but not in sufficient number to be categorized separately.

The trash or incinerator fire was also found to be a hazard to children playing in the area of an unattended fire. In four of the seven cases of this type classified to date the children were apparently playing with the fire when ignition occurred. In the other three cases the children may have been playing with the fire or may have come in contact with it accidentally while playing near it. Often the exact circumstances were not known since no adult was present.

Four cases have been classified in which children were playing with or near an existing fire and flammable liquids were involved. In three instances the child added a readily accessible flammable liquid (usually gasoline) to an existing fire.

4.2. Maintaining or repairing engines or automobiles

This final work-related non-occupational activity, often occurred away from home. It generally involved men of varying degrees of expertise in automotive repairs. The most common accident (9 cases) occurred as the victim was trying to prime a carburetor with gasoline. Either the carburetor backfired thereby igniting the gasoline or the gas spilled on the hot manifold and ignited. The victim was burned by means of one or more of the following:

- As the direct result of flashback
- As burning gasoline splashed or spilled on him
- By the ignition of gasoline or oil previously spilled on clothing.

5. Job Related Activities

Classification of fire accidents occurring while the victim was at work was difficult because of the wide variety of occupations. Tentative occupational classifications decided upon were: agricultural, automotive (maintenance and repair), industrial and other.

5.1. Agricultural occupations

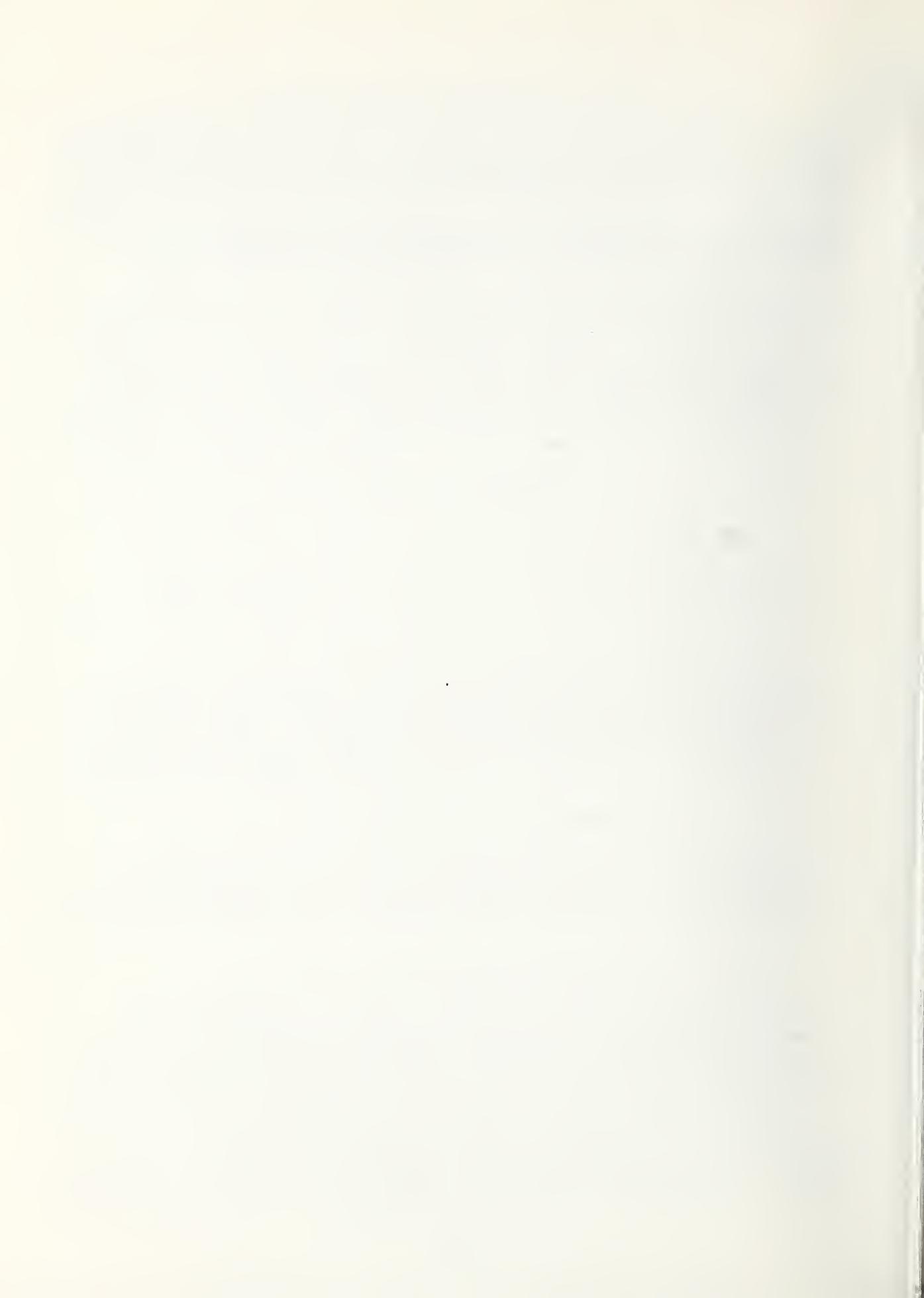
Three of the six cases classified in this category involved a malfunction of, or fire on, farm equipment in use. The other three cases directly involved the use of flammable liquids.

5.2. Automotive occupations

All accidents in this category occurred while the victim was at work in a gas station or garage. All cases to this point also involved flammable liquids. A number of the accidents occurred when an accumulation of gasoline fumes came in contact with an ignition source and ignited explosively. The activities the victims were engaged in when the explosion occurred ranged from using flammable liquid as a cleaning agent to merely carrying the liquid in an open pail. Another typical accident involved ignition of a gasoline contaminated garment as it came near an ignition source.

5.3. Industrial occupations

A wide variety of accident types fell into the industrial occupation category. These accidents often involved torches or welding rods of some sort, sometimes in combination with a flammable or volatile liquid. Malfunctioning equipment caused several accidents and in a few cases the victim was burned by an explosion or flash of flame that he did not cause.

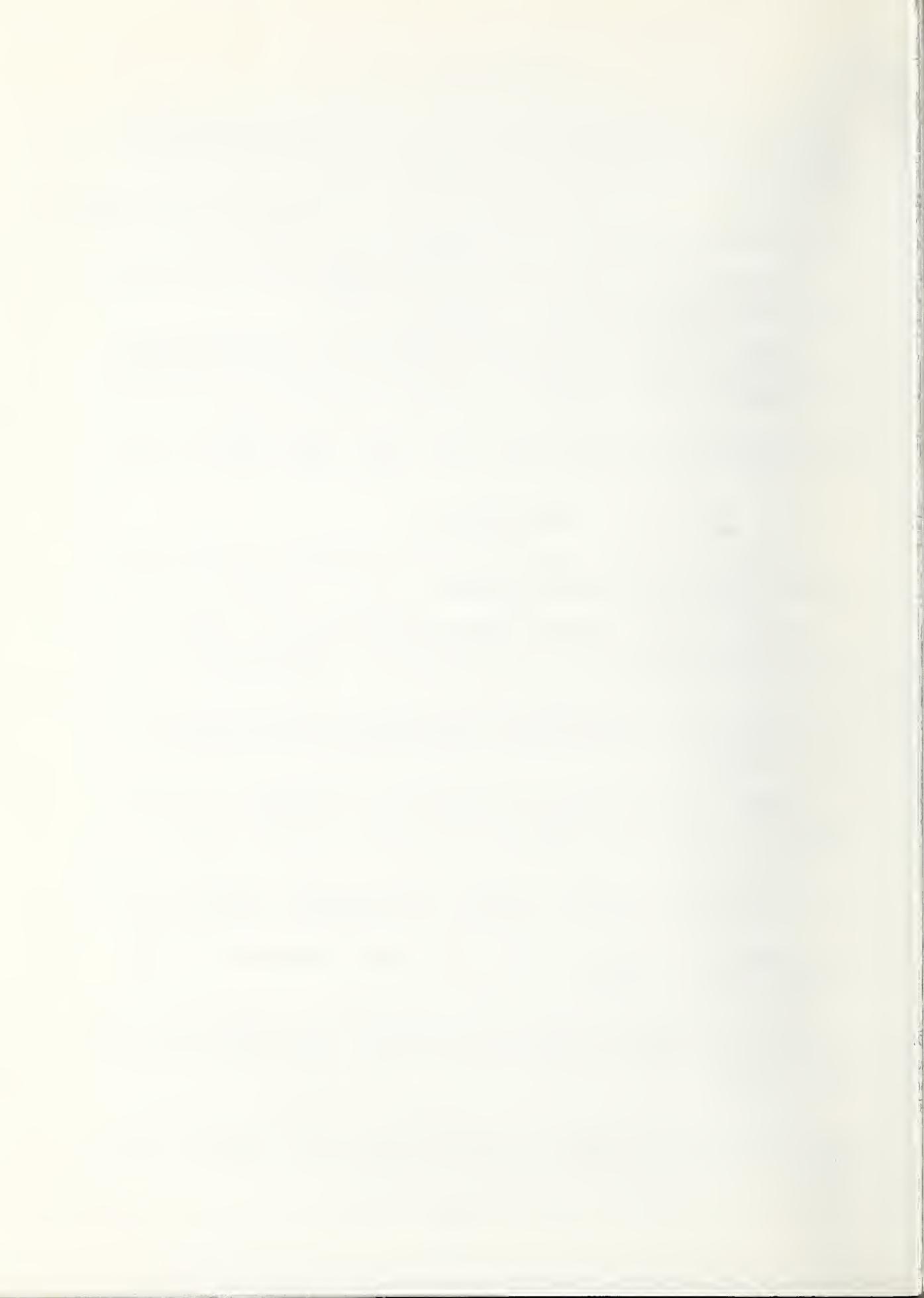


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Fire accidents result from the interaction of a number of environmental, human, and physical factors, all of which may effect the severity of the burn injury. Using information gathered from case histories in the Flammable Fabrics Accident Case and Testing System, this study seeks to identify patterns in the apparel fire accident variables: (1) activity preceding the accident, (2) parameters of fabrics and garments involved, (3) reaction of victim, and (4) severity of the burn injury. It will also attempt to define the extent and nature of the relationships between these accident variables.

This interim report gives a detailed description of the methodology employed in the development and completion of the study, with emphasis on accident pattern identification and classification for apparel fire incidents. Preliminary results of the study are included which identify certain recurring patterns of activity leading to burn injuries.

17. KEY WORDS (Alphabetical order, separated by semicolons) Accident patterns; apparel; apparel fires; burn injury; FFACTS; fire; flammable fabrics; garment fires; garment parameters; injury severity; victim's activity; victim's reactions.

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